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ANOMALIES OF THE OCULAR MUSCLES

FOURTH PAPER

BY

DR. GEORGE T. STEVENS, NEW YORK



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VII.

AN EXAMINATION OF VON GRAEFE'S DOCTRINE OF "ANTIPATHY TO SINGLE VISION."¹

IN Von Graefe's classical description of the condition to which he applies the term "Antipathy to Single Vision," he says: "It has sometimes happened to me that after squint operations with apparently correctly adjusted visual axes there have resulted double images only slightly removed from each other. The visual power of each eye has been quite good, alternating strabismus having previously existed, and the accommodative power has been similar in the two eyes. Nevertheless it has been in no way possible to bring about single vision."²

He states that this condition of double seeing persists notwithstanding the interposition of prisms in various positions, and that every effort of the patient to unite the images results only in removing them to still greater distances.

He adds: "The tendency appears to be a direct physiological contradiction; for while in sound eyes some approach, especially in case of large retinal pictures, is sufficient to induce arbitrary muscular contraction in the interest of single vision, in these cases, on the other hand, it is found that

¹ Read at the meeting of the American Medical Association, May, 1891.

² *Arch. für Ophthalmologie*, i., 1, 117.

exactly the opposite condition prevails, there being an absolute incompatibility to single vision.”¹

In a still later article² he describes the condition more at length, pointing out the fact that the double images, although not far removed, pass from one side to the other, above and below, or one behind the other, always on the point of uniting, but never united. Von Graefe explains the anomaly on the theory, first, of injury to the nervous centres or faulty projection from the retinae, and, second, of the supposed difficulty of obtaining regular associated action between muscles which have long been unaccustomed to association.

A careful examination of many of these cases of “antipathy to single vision” leads me to conclusions different from those arrived at by von Graefe, and the practical application of these conclusions has shown that they are, at least in a great measure, correct. That, in a proportion of these cases, the technical details of disturbing elements may elude our search is undoubtedly true, but that the principles which I shall present will apply very generally I am fully convinced.

In a paper read before the American Medical Association, June, 1889,³ I have already expressed my disbelief in the generally accepted view of the existence of a physiological antipathy to single vision, and my conviction that, by properly selected and properly executed proceedings, this unpleasant condition may usually be eliminated.

The view of the causation of this anomaly, as set forth in that paper, may be briefly condensed into a single sentence.

The condition of antipathy to single vision as described by Graefe and by subsequent authors depends not upon lesion of the brain or faulty projection of the images from the retinae, but upon unequal tension of corresponding ocular muscles under the influence of corresponding nerve impulses directed to them.

I do not assert that no irregularity in projection from the retinae can occur, nor that cerebral lesions may not induce

¹ *Arch. für Ophthalmologie*, i., I, 118.

² *Arch. für Ophthalmologie*, iii., I, 119.

³ Published in ARCHIVES OF OPHTHALMOLOGY, vol. xviii., p. 371.

incurable diplopia. Such cases, if found, will present other and more definite phenomena of the existing ocular or central nervous disease than simply the presence of diplopia. The proposition refers to the cases which come fairly within the class so clearly described and so sharply defined by Graefe.

Excluding then, cases of paresis, and confining ourselves to the class of cases thus defined, we shall find the causation of this supposed antipathy mainly in two conditions. The first of these is acquired as the result of the squint operation or operations. It consists in the fact that by unequal settings back of the insertion of the corresponding tendons, there are induced irregular responses to the impulses directed to these corresponding muscles. In the examination of a very large number of cases, I have found this condition, but generally modified by a second to be mentioned presently, by far the most prevalent. There will be found in such cases either an excessive rotating power, or a power of rotation only moderately restricted, of the muscle of one eye, internal or external rectus, while the rotating power of its direct associate of the other eye is materially restricted. As a consequence of this irregular and unequally balanced condition of opposing muscles no harmonious adjustments can be made, and the more earnestly the patient strives to bring about associated action, the more signally he fails.

That "settings back" of the ocular muscles to an unequal extent may be made with propriety and with success, was taught by the great master, von Graefe, himself, and the practice has been very generally continued to the present time.

It is true that von Graefe advised in extreme cases a division of the operation between the two eyes, but in fact, this was a concession only to most obvious disabilities involved in the failure of the most conspicuously associated movements toward the side opposite the eye operated on, if in a case of converging strabismus, and an impediment to even approximate convergence at near points. Within the limits of extreme results a full correction of the appearance of squint was, according to his teaching, not only permissible

but desirable. This proceeding of making a correction of squint by a single operation has been supposed to be sustained by the theory that the muscle of the squinting eye is pathologically shortened to a considerably greater extent than its antagonist.

It may be conceded that there is, within certain limits of unequal tensions of accordant muscles, a possibility of union of images; otherwise binocular vision would in no case be established except when exact balancing of the tension is secured. That easy and permanent associated action is compatible with any considerable degree of diversity of tension, I do not believe.

It may be objected that if this proposition is correct the proportion of perfect corrections for squint by the prevailing methods of operating must be less than is ordinarily supposed. It is probable that examinations made by methods more exact than those which have been ordinarily employed would show that a very large proportion of cases in which binocular vision has been presumed to have been established by the ordinary squint operation is much smaller than is commonly supposed. However this may be, whether the results of the standard squint operation is often successful or not, it is certain that such unequal tensions are in many instances incompatible with a blending of the images.

A second causative influence, and one which acts as an element in nearly all of these cases, is the difference in relative tension of muscles which act in the vertical direction.

The instinct of bringing images to the same horizontal plane appears to be very great and only second, if indeed it is second, to that of union of images. In case of double images, whatever the difficulty of blending may be, the patient instinctively exerts his best endeavors to place the images in the same horizontal plane. It thus happens, that in certain cases in which, either with or without slight lateral inequality of tension, the effort to bring images to the same plane induces a lateral squint,—a squint which may be variable; that is, such a squint may at one period of life be converging, and at another diverging. Thus, in a case now under my observation, the patient was, during her child-

hood, subject to a very pronounced converging squint. During the past twenty years she has had conspicuous diverging squint, although no operation has been made. Such a condition may properly be called *variable strabismus*, its character of divergence or convergence changing from time to time, remaining possibly in one direction during several years, then changing to the opposite direction.

If in such a case one or both interni or externi are cut, double vision of an intractable form is likely to result. In such cases we must make diligent search for the vertical deviation, a condition often obscure or not at all manifest, before we can succeed in establishing binocular vision.



FIG. I.

I have had the good fortune to obtain a daguerreotype portrait of the lady whose case has just been mentioned, taken during her childhood, and from which I have made an enlarged photograph which I have the pleasure of showing (Fig. I). The photograph shows converging squint, so pronounced that few ophthalmic surgeons even at the present day would hesitate in regarding it as a proper case for a free division of the internus of one, if not of both eyes. Had

such an operation been performed upon this patient in early life, intractable diplopia would doubtless have resulted, and eventually extreme diverging strabismus. In another photographic portrait of this lady, made by myself a year ago (Fig. 2), a moderate appearance of diverging strabismus is seen.



FIG. 2.

In fact a divergence of more than 12° with corresponding crossed diplopia existed. But the most striking feature suggested by this photograph is the left hypertropia, well defined in the position of the eyes and of the brows. The question at once arises whether the change from converging to diverging strabismus is not the result of some radical change in the static condition of the eye-muscles. That this is not the case will be seen by the most cursory glance at the third portrait (Fig. 3), in which the old converging squint has returned. This condition of convergence can be



FIG. 3.

induced at any time by the application of a solution of atropine to the eyes. At the time of taking this third portrait, atropine had been applied twice a day for three successive days, and its effects were complete. A week after

that time the diverging squint had returned and has continued during the year. The transformation from divergence to convergence occurs within an hour after the first application of the atropine, and the present habitual condition of divergence returns as soon as the effect of the drug passes off. This variableness is, without doubt, due to the action of the muscles in the effort to overcome the unequal height of the images, and until the condition of the hypertropia is eliminated such changes of the lateral relations are liable to occur. In passing, a single thought may be given to the adverse testimony of such cases to the well-known doctrine of the relations between the excessive efforts at accommodation and converging strabismus; for here the converging strabismus occurs only when accommodation is neutralized. The present interest in the case centres in the fact that had a free tenotomy of an internus been practised during childhood, the almost certain result would have been an "antipathy to single vision." Even at the present time, when the conditions of hyperphoria and hypertropia are carefully sought for, this patient is able, under many circumstances, to conceal completely the evidence of hyperphoria as shown by the phorometer.

A curious fact in connection with the inequality of tension of the lateral muscles associated with hyperphoria is that a condition which in a passive state of the muscles of either eye or of both eyes is a marked divergence, becomes, as soon as all the muscles are engaged in the act of adjustment, pronounced convergence attended by homonymous diplopia. Conversely, a like change may occur when the tendency is, in the passive state, to converge.

A very practical illustration of what has been stated may be found in an actual history which I condense for this purpose. In a child with left hyperphoria (or hypertropia) the left eye drifted outward during the first few years of life. (Such a diverging squint is rarely observed by parents unless it is extreme.) At length, presumably as the result of a change in the methods of making the efforts to adjust for the horizontal plane, the squint became convergent. The appearance of the eyes of this patient in early childhood is

represented in Fig. 4, which is copied and enlarged from a daguerreotype picture of him taken at the age of about three years.



FIG. 4.

It is to be remembered that in the daguerreotype portrait the features are reversed.

About three or four years later, and after the divergence had given place to convergence, a surgeon performed tenotomies of the two recti interni, presumably severing both tendons completely. The result proving an over-correction, the effect of the operation on one eye was modified by the insertion of a (conjunctival?) suture. The result, in view of what has been stated above, was such as we might anticipate. Double vision of the most annoying character was always present. The efforts of many distinguished surgeons to induce these twin images to unite by means of prisms, even for an instant, were fruitless after trials repeated during many years. The case found a prominent place in ophthalmological literature, endorsed by several distinguished surgeons, as one of the class now under discussion. No case could therefore afford us a better model for our study.

It proved easier for this patient to fix objects with the left eye. That being the case, we may suppose that he would make a certain effort of adjustment with the weakened internus of that eye, which would be associated with a corresponding excessive effort of the opposite internus. But these unequal efforts would also be combined with the effort to adjust for the difference in the positions of the images with reference to the horizontal plane. The result would be an excessive rotation of the right eye to the nasal side with homonymous double images. If, on the other hand, a patient with this combination of defects should look at an object which is isolated from other objects which may serve to aid the disabled eye in active adjustment, as, for instance, at a church spire, or at the moon, or a bright star, in which cases only the clear sky is in immediate relation to the object, the most disabled eye would at once drift outward, and crossed diplopia would result. So also, if a small screen were to be interposed between either eye and the object looked at, thus shutting it out from active participation in the effort of adjustment, the covered eye would diverge in a marked manner and would move inward, perhaps to the extent of one third the diameter of the cornea, as soon as the screen should be removed, and then homonymous diplopia would be observed. Or again, if the subject of such a defect were to look through a grating, as, for instance, through the palings of a picket fence, an object seen beyond the fence would be seen doubled, and the diplopia would be crossed; while an object seen between the person and the fence would be double also, but the double images would be homonymous. In the first instance, looking beyond the fence, the adjusting energy of one eye becomes passive, as in the case of looking at the object against the clear sky, with resulting crossed diplopia. In the other instance, looking at the object nearer than the fence, active adjustment of both eyes occurs with excessive convergence and homonymous double images. All these suppositions and conclusions have been fully justified in the actual treatment of these cases.

In certain cases in which this intractable diplopia exists, the patient has the extraordinary faculty of selecting at will

which eye shall fix the object, and the diplopia becomes homonymous or crossed, according as the one or the other eye is engaged in direct fixation. Thus, in the case of a lady patient, if I direct her to look with the right eye, I can see that the eyes are strongly converged, and she reports the presence of homonymous double images. If I then direct her to look with the left eye, the change may require a few seconds or it may take place very quickly. Then the eyes are plainly seen to diverge, and the diplopia is crossed. In such a case, the nervous impulse directed to the right internus is greater than the normal during fixation with that eye, and when a corresponding impulse is sent to the left internus, the eye is caused to swing in excessively and too great convergence results. On the contrary, when the left eye is fixed, there is no such excess of nervous impulse sent to the left internus, and as no excessive impulse is therefore sent to the right internus, that eye swings outward passively, and crossing of images results. But in this explanation we must not lose sight of the important, probably the most important, element in the causation of the inward swing in many if not in the majority of cases. This is the influence of the difference of tension of the muscles which move the eyes in the vertical direction. This influence is often sufficient, even though the moving power of the corresponding lateral muscles should be equal, to cause a swing beyond that which would result from a given impulse to a lateral muscle. I have rarely met with a case of the so-called "antipathy to single vision" in which this element did not play an important rôle.

It needs no argument to show that the defect which causes the patient to have homonymous diplopia when looking at an object, say at twenty feet distance, and heteronymous diplopia when looking at the same object, if a grating, like the fence of which we have spoken, is interposed between the eyes and the object, or which causes the same patient to have homonymous images when looking at an object surrounded by other objects, and crossed images when looking at an object isolated from visible surroundings, lies neither in the brain nor in faulty projection from

the retinæ, but in peculiar, although perhaps obscure, defects in the adjusting apparatus.

Homonymous diplopia caused by a brain defect or a retinal defect would remain homonymous under all the circumstances which have just been mentioned. Activity or passivity of certain efforts of adjustment could and would be modified by the circumstances mentioned, and the phenomena resulting, which at first appear confused and irregular, are in reality uniform and in accordance with fixed laws.

It is not to be denied that the investigation of an individual case is often surrounded by immense difficulties, or that each new case may present new and perhaps at first incomprehensible phenomena. It is none the less true that all these cases will be found to be governed by known laws. If the difficulties of interpretation of the phenomena in individual cases are great, it demands the greater skill and patience on the part of the investigator in searching out all the various influences which combine to make the defect.

It would probably be impossible, even if all the facts were in our possession, to lay down distinct rules for the discovery of the exact nature of the faulty relations of muscular tension in each case of this class. To attempt it even to the extent to which the principle has been studied, would be to record separately the experience in each individual case. Enough has been said, however, to indicate the lines on which the investigation is to be made.

In the correction of the defect,—this incompatibility to single seeing,—we must logically seek to re-establish a degree of equilibrium between the mobilizing functions of the opposing muscles. To this end, after first correcting the unequal tendency in the vertical direction, it will, in most instances, be necessary to bring the insertion of the disabled muscle forward, and to reduce the tension of the corresponding one of the other eye. This procedure is by no means as easy as might appear. To readjust the tendon after such a setting back as occurs in the standard squint operation, requires in many instances the most persistent and skilful treatment.

Very little can be accomplished by a gross advancement in which the already disabled muscle is made even less flexible than before. The object is secured by progressive steps, one slight advancement preparing the way for another, until the proper degree of rotation with as great flexibility of the muscle as possible is secured. Then the corresponding muscle of the other eye, if it has not been already relaxed, must be made to assume, as nearly as is required, a corresponding adjustment by a careful relaxation.

Such a procedure has, in my hands, succeeded in establishing binocular vision in many inveterate cases of the so-called "antipathy to single vision." The process is often long and difficult, making the greatest possible demands upon the skill, courage, and patience of the surgeon and of the persistent and intelligent co-operation of the patient.

It has been my purpose to do no more than to indicate in a very general way the principle which I would advance, namely, that incompatibility to single seeing usually denotes incorrect methods of operating, and that there can be no effectual correction of strabismus which leaves the tension of the corresponding muscles of the two eyes unequal. The supposed success of many cases in which such inequality is caused by operation, doubtless results from the fact that in the remaining diplopia the images are so widely separated that the patient does not become aware of its existence.

In order to avoid the evil results of diplopia and to secure not only possible but easy binocular vision, then, we must be guided, first, by the actual rotations of the eyes, and by the actual relation of the visual lines not only in the lateral but in the vertical direction. This can be accomplished only when the patient recognizes the position of double pictures, and this according to the theory of identity. There should be no final operation for the adjustment of squinting eyes, until both patient and surgeon are sure of the relative position of the double images.

A precept which I have elsewhere brought forward is in this connection also of essential importance, viz.:

*“Every modification of the length of a lateral muscle, by relaxation or by shortening, which can in any degree effect the rotation of one eye, should in every instance be accompanied by an exactly equivalent modification of the corresponding muscle of the other eye.”*¹

If this precept is correct, the practice of relaxing or setting back of an internus, accompanied by an advancement or shortening of the externus of the same eye while the muscles of the other eye undergo no modification, cannot afford the best results.

The subject of the determination of the relative tensions of the various eye-muscles I have already discussed at some length in a series of articles published in the ARCHIVES OF OPHTHALMOLOGY during the years 1887, 1888, and 1889. It is unnecessary to repeat what has there been said, but there is also much more which might be said in connection with the examination of the relative tensions in these peculiar and most difficult cases, which must be reserved for another occasion.

One point, however, is so important in its relation to the subject under consideration that it should not be separated from it. This is the examination of the comparative rotation of the two eyes in the temporal and in the nasal direction. Something can be learned from an inspection of the movements of the eyes as the surgeon causes the patient to follow with the eyes a pencil or other object as it is carried from side to side, the patient making his best efforts to see it as far toward the extreme outer field of vision at each side as possible. It will in most of the cases, in which the original operation has been performed for converging strabismus, be seen that as the eye on which the operation, or the most extensive operation, has been performed moves toward the nasal side its progress is arrested before the border of the cornea reaches the inner canthus.

The nasal rotation of the other eye will often be found to be free or even excessive. But even the nasal rotation of

¹ Anomalies of the Ocular Muscles, ARCH. OF OPHTHALMOLOGY, 1889, p. 407.

this other eye may be restricted, only in less degree than the first. Similarly we may observe a difference in the temporal rotation. This method of inspection, while it is important and in some measure satisfactory, furnishes less exact information than is required in most cases.

In the measurement of the temporal rotation we have in the perimeter an instrument of sufficient precision. It is my custom to place in the carrier of the perimeter a few capital letters in clear type, of about the size, $2 = D$, of the Snellen scale, and require the patient to see the letters with sufficient clearness to read them. A glass to meet the requirements of the patient's vision is held in such a way before the eye that it is at a right angle to the line between the eye and the test object. Ordinarily a pair of eyes in which no considerable degree of heterophoria exists will make the temporal rotation about 40° each, and no considerable difference in this rotation should exist. In many of the cases under discussion the temporal rotation will be found to differ for the two eyes to the extent of from 10 to 20° . With the new model of the registering perimeter this element can be quickly and accurately determined.

Unfortunately we have no method so accurate for examining the nasal rotation. The full rotation of the eyes in this direction in the normal condition cannot usually be determined by the perimeter, except by the supplementary use of a strong prism. Even with this supplement, the extreme rotation inward of cases of slight converging squint cannot be registered by the instrument. In cases in which the rotation does not much exceed the line of vision across the bridge of the nose, we may place a rounded prism with its apex in the canthus. Two degrees of prism equals one degree of the perimeter. Hence a prism of 10° , apex in the canthus, may cause the eye to turn inward 5° more than it would if looking directly at the object. The expedient of placing a scale of degrees on the lower lid and reading from it the nasal rotation, while inaccurate, is sometimes the only recourse, and the best use of an unsatisfactory method must be made.

